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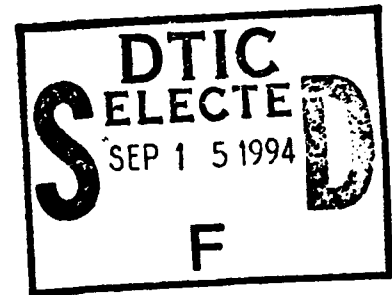
Franchise Plan
Central Archive for Reusable Defense Software
(CARDS)

Informal Technical Report

Central Archive for Reusable Defense Software

STARS-VC-B010/001/00
28 February 1994

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INFORMAL TECHNICAL REPORT
For The
SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS
(STARS)

Franchise Plan
Central Archive for Reusable Defense Software
(CARDS)

DRAFT-STARS-VC-B010/001/00
28 February 1994

Data Type: Informal Technical Data
Contract NO. F19628-93-C-0130
Line Item 0002AB

Prepared for:

Electronic Systems Center
Air Force Material Command, USAF
Hanscom AFB, MA 01731-2816

Prepared by:

DSD Laboratories, Inc.
under contract to
Unisys Corporation
12010 Sunrise Valley Drive
Reston, VA 22091

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ject to change. For further information, contact the authors at the following mailer address:
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INFORMAL TECHNICAL REPORT
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Central Archive for Reusable Defense Software
(CARDS)

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(Signatures on File)

Data Reference: DRAFT–STARS–VC–B010/001/00
INFORMAL TECHNICAL REPORT
Franchise Plan
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ABSTRACT

The Central Archive for Reusable Defense Software (CARDS) Franchise Plan is a tool to help management, with assistance from CARDS, develop a detailed, tailored implementation plan which will prepare the organization to begin the process of software reuse.

The CARDS Franchise Plan is targeted toward management level personnel and is meant to introduce reuse and obtain assistance from programs such as CARDS to do reuse.

The Franchise Plan presents a planning process for building a reuse infrastructure. To establish a reuse infrastructure, the Franchise Plan will describe the steps that need to be accomplished:

1. Establish management commitment for reuse

2. Develop:

    a. An Organizational Assessment which defines an organization's current state of affairs, and assesses its potential for reuse;

    b. A Requirements/Implementation Study which determines the organization's requirements for instituting reuse; and

    c. A Reuse Implementation Plan which describes those steps necessary to implement a reuse infrastructure.

This document is an update to CARDS Franchise Plan, STARS-AC-04116/001/11, 30 March 93. [CARDS93d]

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Department of the Air Force ESC/ENS Hanscom AFB, MA 01731-2816	10. SPONSORING/MONI-TORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT DISTRIBUTION "A"	12 b. DISTRIBUTION CODE

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Table of Contents

1 Introduction

1.1 Purpose

Facing shrinking defense budgets, and growing demand for software to control sophisticated and complex weapons systems, the Department of Defense (DoD) is focusing software reuse efforts on life cycle products for all types of software-intensive systems. As stated in the DoD Software Reuse Initiative Vision and Strategy document the goal of the DoD is:

> *To drive the DoD software community from its current "re-invent the software" cycle to a process-driven, domain-specific, architecture-centric, library- assisted way of constructing software. [DoD92]*

Making domain-specific reuse a part of the way software is developed requires a reuse infrastructure be developed. For the purposes of the Franchise Plan, the reuse infrastructure is defined as: *a combination of policies, processes, technology, and personnel required in an organization to incorporate reuse into the software development process.* The Franchise Plan will define a planning process for building a reuse infrastructure.

The Central Archive for Reusable Defense Software (CARDS) Franchise Plan is a tool to help management, with assistance from CARDS, develop a detailed, tailored implementation plan which will prepare the organization to begin the process of software reuse.

1.2 Scope

The Franchise Plan is targeted toward management level personnel and is meant to introduce reuse and obtain assistance from programs such as CARDS to do reuse.

The CARDS Program can support the creation of franchises defined *as an organization that is committed to developing a domain-specific reuse capability, and*

- forms reciprocal obligations and a cooperative partnership with CARDS;

- has a business agreement with CARDS that enumerates the range and level of services to be provided by CARDS and obtained from the franchise; and

- shares a process-driven, domain-specific, architecture-centric, library- assisted technical vision with CARDS.

To establish a reuse infrastructure, several steps need to be accomplished:

1. Establish management commitment for reuse

2. Develop:

a. An Organizational Analysis which defines an organization's current state of affairs, and assesses its potential for reuse;

b. A Requirements/Implementation Study which determines the organization's requirements for instituting reuse; and

c. A Reuse Implementation Plan which describes those steps necessary to implement a reuse infrastructure.

3. Execute the Reuse Implementation Plan by:

a. Establishing a CARDS Franchise; and

b. Building a reuse infrastructure.

2 Approach To Franchise Planning

2.1 Prerequisite: Management Commitment

The success of software reuse in an organization depends on management's commitment to support the implementation of plans and activities, with continual involvement and to be strong reuse advocates. [CARDS92b]

Management, with its control of budgets and strategic planning, should take responsibility for the implementation of policies and guidelines which will ultimately lead to institutionalized reuse. It is not enough to simply mandate a change; management should get involved in the early stages, and stay involved throughout the entire process. Sample levels of management and their respective responsibilities are depicted in Table 2-1 [Reuse92]

Table 2-1 Organizational Reuse Responsibilities

Organizational Levels	Reuse Responsibilities
Direction Level Managers	Commitment to reuse
Program Executive Officers	Allocate resources to establish reuse
Designated Acquisition Commanders	Provide vision and strategies
	Provide policies and procedures
	Develop (service-wide) implementation plan
	Provide Incentives Continued Involvement
Mid-level Managers	Commitment to reuse
Program Managers	Identify and allocate resources
	Develop (organizational) Implementation plan
	Continued involvement Interface with external resources
Unit Managers	Commitment to reuse
Project Leaders	Identify and allocate resources
Team Leaders	Develop (organizational) Implementation plan
	Continued involvement
	Interface with external resources
Individual Contributors	Commitment to reuse
Implementation Engineers	Rationale for Reuse
	Continuous Improvement
	Designing with/for Reuse
	Collect lessons learned

To achieve maximum benefit from a reuse infrastructure and change the way the organization is doing business, management has to make a long-term commitment. Management should follow up the commitment with training, resources and other investments which may include identifying new personnel, such as domain engineers, domain managers, or other reuse or domain experts.

2.2 Planning Phases

Figure 2-1depicts the phases necessary for implementing a reuse infrastructure. The Franchise Plan will cover those areas contained in the shaded boxes. The numbers within the shaded boxes correspond to the Franchise Plan chapters that describe these phases.
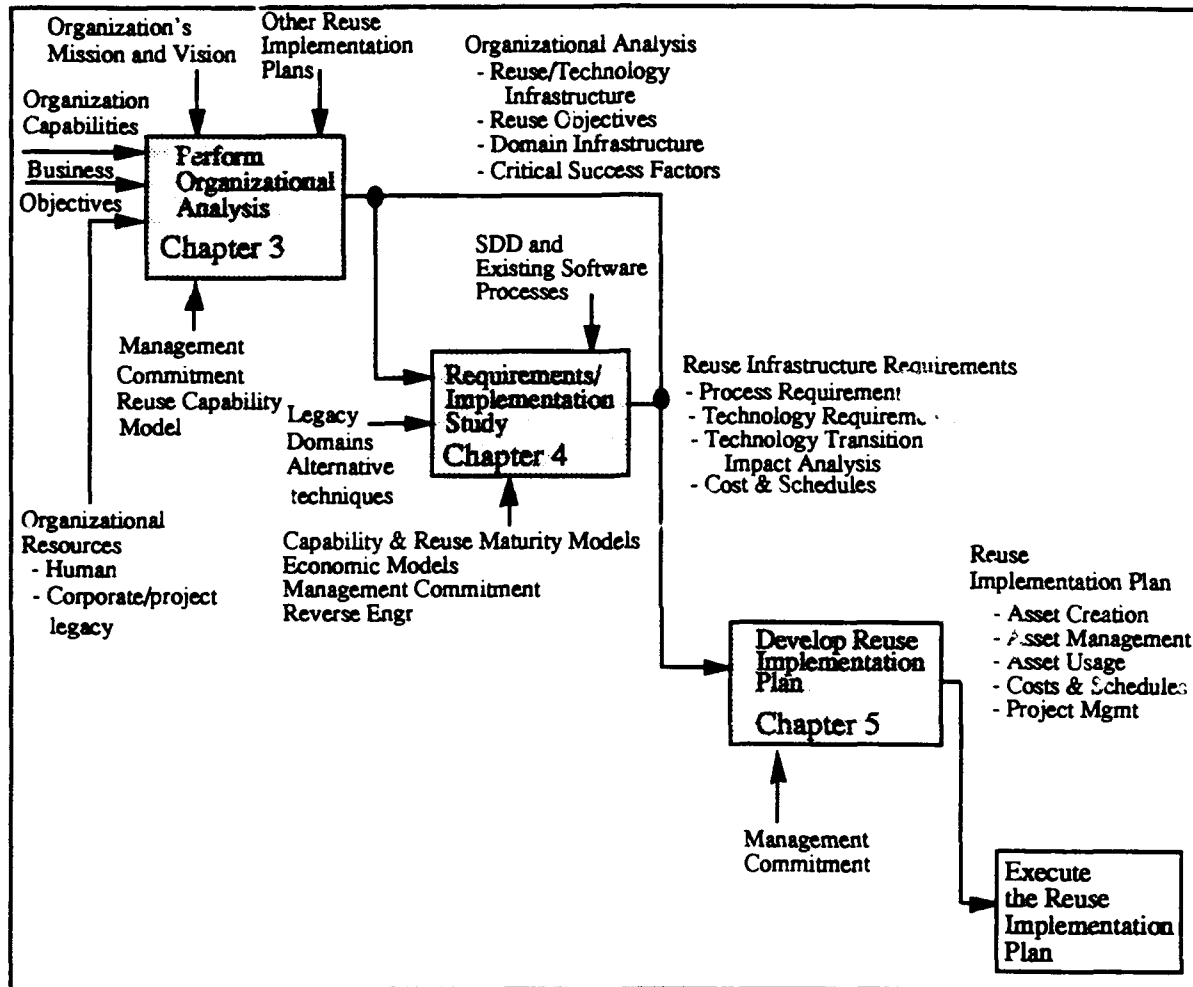
Figure 2-1 Planning Phases

The phased approach is a method used to control the process. By breaking the implementation process into phases, the analyst and developer of the plan are forced to think the process through, and digest the implications at each step. The phased approach allows "fine tuning" as the process evolves resulting in products tailored for the requirements of the organization.

The Organizational Analysis will provide an understanding of the current state of the organization and an analysis of the organization's potential for reuse.

The Requirements/Implementation Study extends the organizational analysis, studies the alternatives, produces the requirements for an organizational reuse infrastructure and an estimate of the cost and schedule of implementing reuse.

Based on the requirements for the organization's reuse infrastructure, the next task is to design in detail exactly how the reuse infrastructure will be implemented and produce the Reuse Implementation Plan.

Tailoring the process allows the organization to consider what best fits their requirements. Budget, personnel, and the organization's objectives will be major factors in the decision making process. The organization should determine their requirements and available level of investment. For example, it is conceivable that some organizations will decide to implement a comprehensive reuse infrastructure complete with an in-house library and all the support necessary for it's operation. Others may decide on third party libraries as a business solution. Still others may use a combination in varying degrees of the two previous scenarios. Whatever solution and to whatever degree, the Reuse Implementation Plan should address the pertinent issues such as, domain analysis, technology insertion, library access, etc.

The Organizational Analysis [Chapter 3] describes a process that assesses the business requirements and the critical success factors necessary to facilitate reuse planning. The Requirements/Implementation Study [Chapter 4] describes a process that assesses the output from the organizational analysis, the domain requirements, financial requirements and the software process requirements necessary to recommend a strategy for implementing reuse. Chapter 5 describes the activities that produce the necessary parts of a Reuse Implementation Plan and the decisions that must be made pertaining to asset creation, asset management and asset utilization.

2.3 Analysis Activities

The DoD Software Reuse Vision and Strategy [DoD92] depicts the broad range of factors which will influence the successful adoption of software reuse. Reuse technology must ultimately address many of these factors, including the unique characteristics of application domains, business processes, engineering processes, and the critical success factors for software products being developed. Since these factors may vary among CARDS Franchises, the supporting technology will also vary. That is, a "one-size fits all" technology approach to reuse is unsuitable.

To support the identification and insertion of needs-tailored reuse technology, two related activities need to be undertaken:

- An Organizational Analysis, to characterize the existing technology, business needs and determine critical success factors. This information will provide both the raw materials and insertion base for reuse technology. [See Chapter 3 "Organizational Analysis"]

- A Requirements/Implementation Study to identify an organization's unique requirements and the technology needed to support these requirement. [See Chapter 4 "Requirements/Implementation Study"]

Successful reuse adoption involves critical factors identified during analysis. Figure 2-2 illustrates the areas that require analysis for reuse infrastructure development:
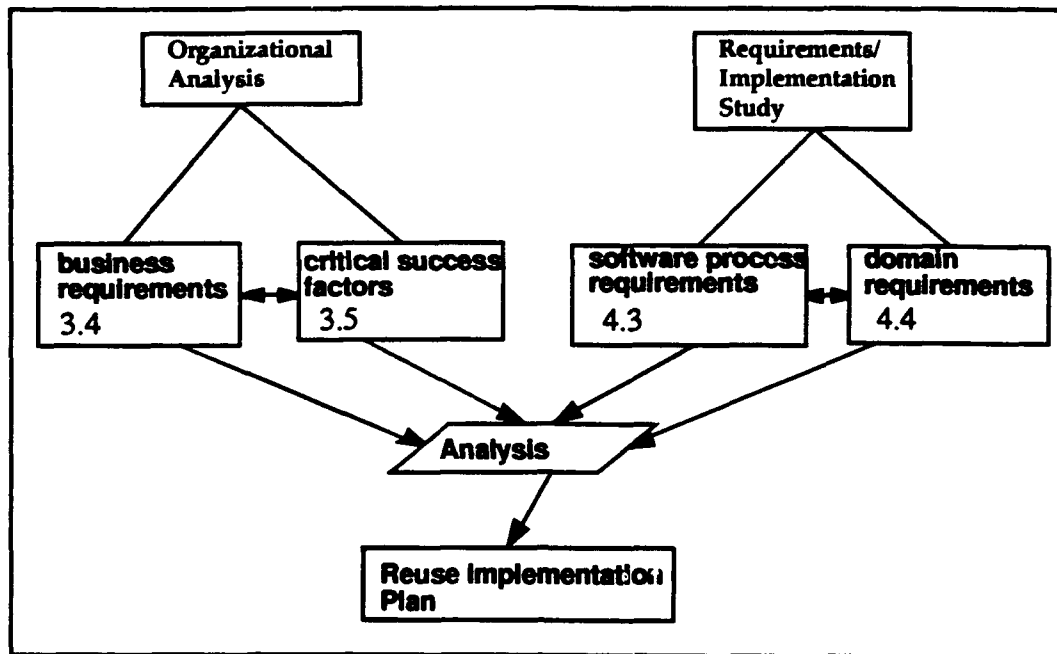
Figure 2-2 Reuse Analysis Activities

- Business Requirements which define the unique attributes of the organization; [3-4]

- Critical Success Factors which define the "things that must go right" for a successful reuse program; [3-5]

- Software Process Requirements which define the reuse software process that will be employed by the organization; and [4-3]

- Domain Requirements which define the domain driven requirements. [4-4]

3 Organizational Analysis

3.1 Purpose

For an organization to fully comprehend the benefits of reuse, and to gauge the magnitude of change required to achieve the benefits, information needs to be collected and analyzed about the organization's capabilities and objectives. The Organizational Analysis identifies the critical success factors (CSFs), key assumptions and existing capabilities. The Organizational Analysis will define "where I am", and" where I want to go "and "what capabilities I have to get there".

3.2 Approach

One approach for the organizational analysis is to use interviews, surveys, questions, and information on past software development projects to identify the goals and objectives, domain infrastructure, the critical success factors and current technology infrastructure. Information needs to be collected on personnel, equipment, facilities, and processes dedicated to software engineering from both management and technical personnel.

> *To increase the understanding of the organization, it's goals and objectives, the affect of reuse on the organization, it is necessary to place the organization in perspective. This perspective is accomplished by identifying the organizational units, locations, and functions. [MAR90]*

The business requirements will be determined by assessing the organization's goals, objectives, domain infrastructure and technology infrastructure. The information from the analysis of the business requirements will provide the knowledge necessary to formulate the critical success factors for the organization's reuse effort. Both the CSFs and the business requirements will be analyzed and the Organizational Analysis produced. [See Figure 3-1].
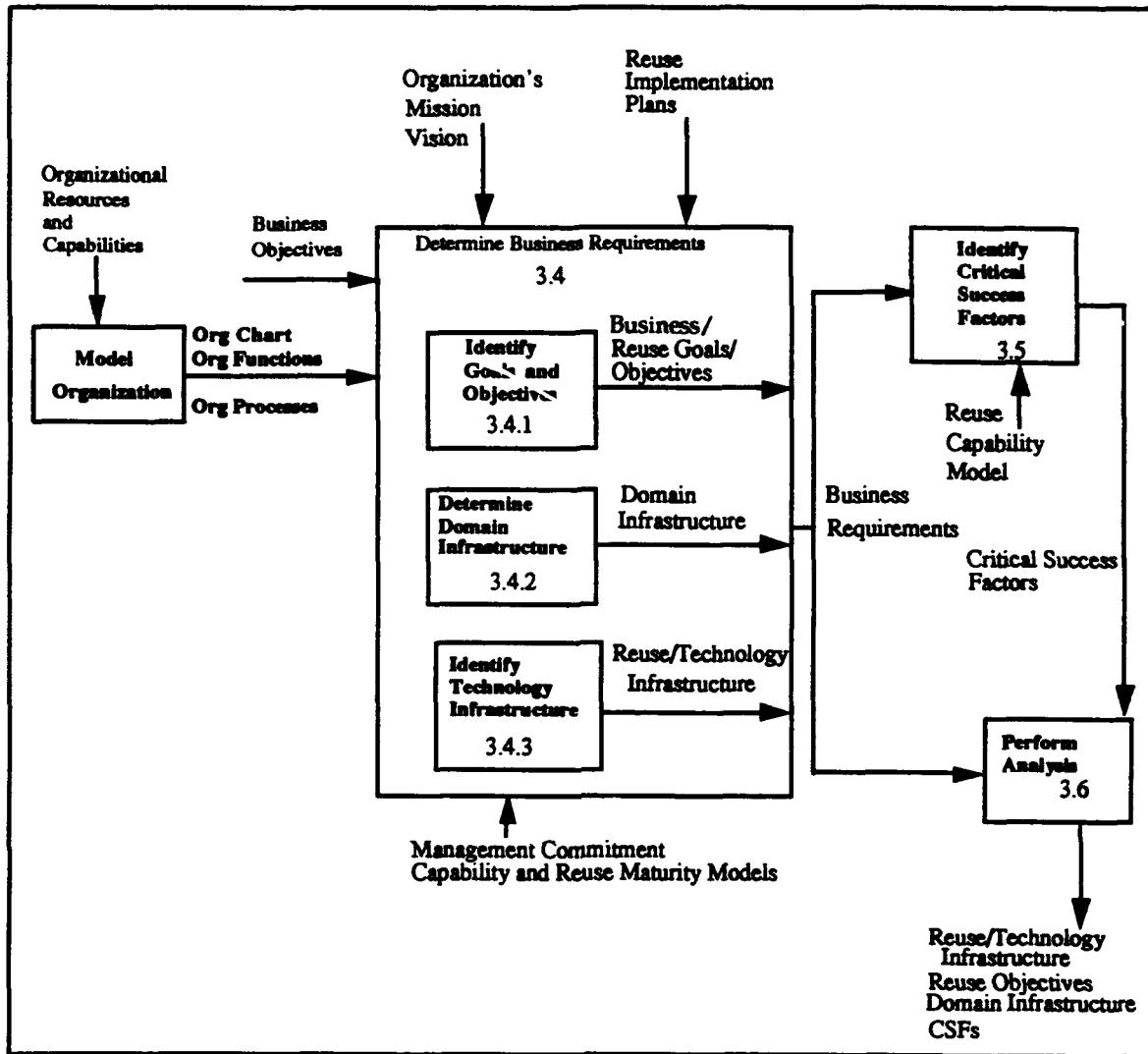
Figure 3-1 Organizational Analysis

3.3 Modeling an Organization

The structure of an organization can be understood by developing an organizational chart and assigning the functions and processes to the proper unit.

3.3.1 Organizational Chart

The organizational chart will provide the management and functional structure for the organization. The chart should list the units within the organization using a structured chart. Each unit should list as appropriate a manager, functions and processes. Understanding these facets of

the organization will facilitate the organizational analysis and the eventual reuse implementation plan.

3.3.2 Organizational Functions

Once an organizational chart has been developed, for each unit the activities performed should be recorded. For our purposes, those activities directly associated with software development will be recorded. Functions are developed as part of strategic planning.

Possible activities within the software development process could be:

1. Domain management: domain engineering;

2. Software development - analysis, design, coding, testing, integration;

3. Quality assurance; and

4. Process improvement.

Organizational Functions may be defined as:

- A group of activities that together support one aspect of furthering the mission;

- A function is ongoing and continuous;

- A function is not based on organizational structures;

- A function categorizes what is done, not how; and

- A function name should be a noun or a gerund (a word ending in "ing").

3.3.3 Organizational Processes

The processes are those that an organizational unit performs to achieve the unit functions. A process at this point addresses the what, not the how. For instance, "perform domain analysis". Processes are part of the business area analysis.

Processes:

- Are a specified activity in an enterprise that is executed repeatedly;

- Defined in terms of Inputs and outputs;

- As having definable beginning and ending points;

- Are not based on organizational structures;

- Identifies what is done, not how; and

- Are named using an action verb.

3.3.4 Summary

The model of the organization should include:

1. An organizational chart showing all organizational units;

2. The persons who manage the organizational unit;

3. The major business functions;

4. The processes of each organizational unit

5. A matrix mapping managers and functions against the following:

   a. Direct management Responsibility

   b. Executive or policy-making Authority

   c. Involved in the function

   d. Technical Expertise

   e. Actual execution of the Work

3.4 Determine Business Requirements

To reduce the difficulty of reuse insertion into the way an organization develops software, it is necessary to understand the current state of the organization (business and technology practices). The Business Requirements will provide the necessary foundation for a unique organization tailored Reuse Implementation Plan. To build this foundation, it is necessary to:

- Identify the business goals and objectives that will form the basis of the reuse goals and objectives; [3-4.1]

- Identify the domain infrastructure and determine if the domain is suitable for domain-specific reuse; and [3-4.2]

- Identify the current state of the organization's technology infrastructure. [3- 4.3].

All of the above factors will be considered to produce the Business Requirements that include:

- Business goals and objectives;

- Reuse objectives;

- Description of the domain infrastructure;

- Description of the current technology infrastructure; and

- Requirements for redirection of and addition to the reuse/technology Infrastructure.

3.4.1 Identify Goals and Objectives

Rationale

To help evaluate the information that is gathered during the Organizational Analysis and develop the reuse objectives, it is important to identify the business goals and objectives of the organization. The goals and objectives of the organization will provide a foundation for the recommendations and reuse objectives that are presented in the Organizational Analysis Report. They should also reinforce the motivation to institute reuse.

Input

Goals can be extracted from a variety of documents in an organization, for example: technology plans, monthly reports, executive reports/memos and management documentation.

Processes

The reuse objectives will be formed using the organization's goals and objectives. For example, an organizational goal could be "increase productivity" and a reuse objective that can support this goal could be "increase the amount of software assets that are reused instead of created from scratch". This example shows support of one organizational goal with a reuse objective. By supporting management's goals, the chances of attaining management commitment will be increased.

The goals/objectives can be developed within the context of an organizational chart. Related goals and objectives should then be tracked throughout the organizational chart. The higher-level goals will help determine the lower-level goals of an organization. For example, goals mentioned above may be related on the organizational chart as:

- Program Executive Officer - "Decrease software costs" (organizational goal)

- Program Managers - "Increase productivity"; (organizational goal)

- Unit Manager - "Increase the amount of software produced by each person"; (organizational objective)

- Team Leaders- "Increase the amount of software assets that are reused instead of created from scratch". (reuse objective)

To determine the business goals and objectives and formulate the reuse objectives, the analyst should:

- Determine the mission and vision of the organization by interviewing management personnel;

- Use the organizational chart to organize goals and objectives;

- Collect and evaluate written sources of goals and objectives;

- Interview management to understand their perspective of the organization and any problems that may inhibit the goals and objectives;

- Prioritize the business goals;

- Formulate reuse objectives that support the organization's goals and objectives;

- Agree on the reuse and business objectives of the organization;

- Determine current potential barriers to activating a reuse program;

- Discuss solutions to these barriers;

- Gain executive rapport and involvement; and

- Determine how reuse can help achieve the goals.

Typical questions would be:

1. What are your responsibilities? Are they different from those indicated on the organizational chart?

2. What are the basic goals of your area?

3. What are the three greatest problems you have had in meeting these goals?

4. What has prevented you from solving them?

5. What value would reuse have in this area?

6. How are you measured?

7. How do you measure your subordinates?

8. What other types of measurement are you expected to make?

9. What is the current knowledge and skills of personnel?

10. How would you describe the services provided by your organization?

11. Do you have a customer demand for many versions of your products?

12. Do you have a need for prototypes?

13. Do you have reduced staff to cover future demand?

14. How well does your management facilitate reuse?

Output

The output from this task should document the reuse objectives in context of:

- The business goals and objectives;

- The existing organizational structure with goals and objectives associated with each unit;

- Priority of the business goals;

- Reuse objectives that support the business goals and objectives;

- Problems that may inhibit the goal;

- If possible a recommended reuse solution;

- Business requirements that support reuse goals; and

- Impact on organization.

3.4.2 Determine Domain Infrastructure

Rationale

To support the DoD Software Reuse Initiative Vision and Strategy it is essential for an organization to have a domain that is a candidate for domain analysis and the formation of

a generic architecture. For purposes of the organizational analysis a domain is defined as: *An area of activity or knowledge containing applications which share a set of common capabilities and data.*

The identification methodology and evaluation criteria for selecting a domain is a critical first step in determining if and/or how to implement reuse at an organizational level. The domain infrastructure is determined by evaluating established criteria for domain stability, available domain expertise, and existing software processes that could support domain analysis.

Inputs

Information will be gathered from studying current and past software projects, interviewing both management and technical personnel and identifying the organization's goals and objectives for the future that could impact the implementation of domain-specific reuse.

Processes

The following list of questions should be addressed to determine the viability of an organization's domain of interest, the characteristics of the domain and the capabilities of the organization to do reuse within the domain:

- Do well defined software processes exist in the domain? If so, can they be qualified and measured (metrics)? *An answer of yes will increase the organization's capability to do reuse and measure the impact of the changes imposed by reuse.*

- Is there a sufficient knowledge base to support the domain analysis? Are there in-house experts available to analyze the domain? If not, are there resources to hire software engineers or consultants? Does codified experience exists that can predict technology and provide domain expertise? *The amount of organizational (or external) knowledge available will help define the requirements for human resources that are needed to build a domain-specific reuse capability and will help determine the feasibility of such an endeavor.*

- Is the domain under consideration mature and stable? *To do domain-specific reuse the available information should be somewhat static with areas of commonality and variability definable. Reusable assets should have the potential to be used frequently before becoming obsolete or needing major changes.*

- Will the domain form a key part of an organization's future "business"? Is there competition within the domain? Are there opportunities for strategic or short term partnerships for development? *Doing reuse in a domain should support the organization's goals and objectives for the future.*

- Is the size of the market (now and future) for systems in the domain stable and growing? *What is the economic viability of doing business in the domain, from a return on investment standpoint? What are the current and predicted market forces which provide motivation?*

If domain-specific reuse appears to be a viable alternative for reuse within the organization, then domain-specific reuse objectives should be formulated based on the organization's general goals and objectives.

Typical questions would be:

- What are the products produced by your area?

- What application domain or domains are you currently working in?

- What is the experience level of your personnel within this domain in number of years and/or number of domain related projects?

- What are the number of projects your organization has developed within this domain?

- Do you have a domain architecture that you reuse?

Output

The output from this segment of the Organizational Analysis will describe the current domain infrastructure by:

- Producing an analysis of the organizational domain capability and expertise;

- Generating domain-specific reuse objectives; and

- Defining the domain-oriented business requirements, such as human resource needs for domain analysis, based on the analysis and domain- specific reuse objectives.

3.4.3 Identify Technology Infrastructure

Rationale

In order for an organization to fully comprehend the benefits of reuse and to gauge the magnitude of changes required to achieve those benefits, information needs to be collected and analyzed about the current technology infrastructure. The Organizational Analysis will identify areas where resources need to be redirected or applied.

Inputs

The inputs to this process are:

- The business and reuse objectives, as described above, to provide the context in which the technology requirements will be evaluated; and

- The processes and organization's resources such as human, corporate/project legacies, and current software and hardware.

Processes

Personal interviews, surveys, and information on past software development projects will be used to develop alternative solutions and to tailor an approach designed for each organization. Software process-related information (e.g.,CASE usage, software methodology) needs to be collected on personnel, equipment, and facilities dedicated to software engineering from Management and technical personnel.

Typical questions would be:

- Do well defined software processes exist within your organization? If so, characterize.

- How do you capture lessons learned?

- How do you decide trade-off decisions for formulating requirements?

- Do you review previous projects to formulate requirements for a new project?

- What automated software development tools are a part of your software development process?

- Do you use a formalized method for developing software? If so what?

- Are process metrics collected?

- What product quality metrics are collected?

- How are the metrics used?

- What software engineering environment do you use?

Reuse Capability

- Do you reuse any portion of previous projects on current projects? If yes:

  - At what time during the life-cycle do you incorporate the reusable parts?

  - What is the estimated percentage of current projects that are reused parts?

- Do you have a library for reusable parts? If so, characterize contents.

- Is reuse done on an individual, team or organizational level?

- Is the concept of domain analysis an accepted part of your software development process?

- What languages are used in the reusable parts?

- Is there an organization unit responsible for developing reuse action plans?

- Is there a formal or informal way of identifying reuse opportunities

- Is planning for reuse part of the project planning cycle?

- Is data on the investment in reuse maintained?

- Are reusable assets created by an independent development team? If yes, how many people are involved and what are their roles?

- Is there any special training provided for creating reusable software?

- How important are tools in creating reusable assets?

- Are there any standards used for constructing reusable assets?

- Did you collect any metrics on the development of reusable assets?

- Is an organization unit responsible for reusable libraries on a project?

- Who is responsible for the library?

- Describe the services available from the library?

- Are library usage metrics collected?

- How has library usage changed over time?

- Is there an asset certification process?

- Is there an asset qualification process?

- Do you have agreements for providing reusable assets to external groups or organizations?

- What has facilitated/impeded the reuse of available components?

- Have testing practices changed since introducing reuse?

- Do you have agreements for using reusable assets form external groups or organizations?

- Do you provide usage reports back to the library?

- What are the goals of your reuse program?

- What up-front investment was required to add reuse to your process?

- What success have been achieved?

Outputs

The outputs from this segment of the Organizational Analysis will identify the resources available to build a reuse infrastructure and the business requirements for redirecting those resources. To build a reuse paradigm in an incremental fashion, we should consider utilizing the current technology within the organization whenever possible. We need to describe the current infrastructure in terms of:

- Software process being used;

- Operational hardware and software;

- Quantity of software produced;

- Quantity and quality of assets currently available; and

- Controls that are in place, for metrics collection and analysis.

3.5 Identify Critical Success Factors

Rationale

Critical Success Factors (CSFs) are the limited number of areas in which satisfactory results will ensure competitive performance for the individual, department, or organization. CSFs are the few key areas where "things must go right" for the organization to flourish and the manager's goals to be attained. [MAR90]

Inputs

The inputs to CSF analysis are the business/reuse goals and objectives[3.4.1], corporate expertise in the application (domain infrastructure) area [3.4.2], and the current technology infrastructure [3.4.3].

The goals and objectives are needed to determine the management CSFs, such as organizational commitment, planning and direction. The current technology will help define the tools support and technology innovation that may be critical to an organization's reuse effort.

Application expertise is needed to characterize the attainable CSFs related to the technical attributes of software assets and the products developed from them; this expertise will be tapped through structured interviews with selected application experts within domains of interest to the organization.

The Reuse Capability Model (RCM) [SPC92b] provides a source for possible CSFs. The factors are organized into four groups: management, application development, asset development, and process and technology [See Table 3-1]. The management factors correspond to issues critical to management's role in facilitating reuse. The application development factors correspond to issues critical to the utilization of reusable assets in the development of end products. The asset development factors correspond to issues critical to the acquisition or development of assets for reuse. The process and technology factors correspond to general process issues which are applicable across the management, application development, and asset development views. [SPC92b].

Table 3-1 Possible Critical Success Factors [SPC92b]

Management Factors	Application Development Factors	Asset Development Factors	Process & Technology Factors
Organizational commitment	Asset awareness and accessibility	Needs identification	Process definition and integration
Planning and direction	Asset identification	Asset interface and architecture definition	Measurement
Costing and pricing	Asset evaluation and verification	Needs/solution definition	Continuous process improvement
Legal/contractual constraints	Application integrability	Similarity/variation definition	Training
		Asset value determination	Tool support
		Asset reusability	Technology innovation
		Asset quality	

Processes

CSFs may be identified in a top-down fashion. First establish CSFs for the executive branch of the organization and then for each branch below on the organizational chart. The CSFs will be defined in terms of one or more business goals and objectives and the reuse objectives.

In order to support the CSFs or as part of the CSFs, three other things must be considered:

- Critical Assumptions which are a group of assumptions about a business segment that supports or validates an organization's CSFs;

- Critical Decisions that must be made by an organization to have an impact on its CSFs; and

- Critical Information that is required by an organization's operational system to enable them to support the organization's CSFs.

A proposed methodology [MAR90] would include:

- Preparing for the CSF analysis by learning all about the organization and external relevant information (organizational information determined while defining the business requirements);

- Holding an introductory workshop to illicit information from top management that will lead to identification of the CSFs;

- Conducting individual interviews with management and technical personnel;

- Producing a consolidated report; and

- Reviewing and distributing the consolidated report to top management.

Discuss the interviewee's view of the organization. Determine that the interviewee under stands CSFs and the purpose of the interview. Have the interviewee describe his role and mission in the organization. Have the interviewee identify their goals. Discuss problems that the interviewee perceives within the organization.

Three questions that may help elicit the CSFs are:

1. What are those things you see as critical success factors for your job at this time?

2. In what one, two, or three areas would failure to perform hurt you the most? Where would you hate to see something go wrong?

3. If your were isolated from the organization for two weeks, with no communication at all, what would you most want to know about the business?

To check the validity of the interview, the interviewer should determine if:

- Have external CSFs been considered as well as internal CSFs: for example, regulatory mandates, market forces?

- Have building CSFs, those that change the organization structure or processes, been considered: for example, restructuring the organization, new product lines, uses of new technology?

- Have short-term factors been considered: for example, current crisis, budget overruns?

- Have CSFs been considered that relate to:

- the position or viewpoint of the manager of the organization?

- activities of competition?

- the industry in general?

- Make sure that the list is not limited to CSFs that are appropriate to reuse only. The objective is to elicit all software development needs.

- Eliminate redundant CSFs.

- Ensure that past and future concerns are discussed as well as the present.

The CSFs should be prioritized in some manner. It is also important to discuss the measurement of the CSFs.

Outputs

The output of this process is the identified, prioritized CSFs based on the business goals and objectives and the reuse objectives. The prioritization of the CSFs will depend largely on how the business goals, objectives and reuse objectives were prioritized.

3.6 Perform Analysis

As shown in Table 3-1, an analysis activity occurs that analyzes the CSFs, and the business requirements, as described above, and consolidates the information into a cohesive organizational analysis of reuse maturity.

This analysis activity should address these issues:

- How can the organization's goals and objectives be supported by reuse?

- Can the current software and hardware support a reuse program?

- What are the software maturity capability factors related to reuse success?

- What are the reuse objectives?

- What are the critical success factors?

- What resources can be committed?

The Reuse Capability Implementation Model [SPC92] has arranged the CSFs for each category by reuse capability stages. For each CSFs the RCM identifies goals that should become part of the reuse strategy at various capability stages. Using the RCM and the information collected thus far assess the reuse capability of the organization in the short term and the long term.

Identify those aspects that are clearly feasible now and the reuse CSFs that may not fit into the organization's business goals and framework.

Output

An Organizational Analysis report that contains:

- The reuse/technology infrastructure;

- The reuse objectives and business goals and objectives;

- The domain infrastructure;

- The critical success factors;

- An analysis of reuse maturity based on the current goals and objectives and the technology infrastructure; and

- A recommendation as to what level of reuse is feasible for the organization, for instance domain model, architecture, or implementation asset reuse.

See "Organizational Analysis Sample Outline" on page A-1. for suggested content areas for this analysis report.

4 Requirements/Implementation Study

4.1 Purpose

The Requirements/Implementation Study will balance requirements imposed by an organization's; reuse objectives, technology infrastructure, critical success factors, software process and reuse process maturity, process improvement strategies and characteristics of the underlying application domain to produce a specification for an organization-tailored reuse infrastructure.

The Organizational Analysis provided an understanding of the domain, objectives and goals, current technology environment and critical success factors of the organization. Based on this information, the purpose of this Study is to identify the appropriate reuse infrastructure requirements for an organization.

The Organizational Analysis defined "where I am", "where I want to go" and "what capabilities do I have to get there". This Study will define "how do I get there" and "is it cost effective".

4.2 Approach

Figure 4-1 depicts the four tasks that will determine the Reuse Infrastructure Requirements. Two primary tasks identify the software process and domain requirements. A third task of equal importance is the impact analysis. Once all the information is gathered and the impact assessed, then the data is analyzed to produce the Reuse Infrastructure Requirements.

The software process requirements will be developed by evaluating the existing software processes, the reuse/technology infrastructure, the reuse objectives, the domain infrastructure and CSFs. The current capability models [STARS92c, SPC92b] for software process maturity should be used as references to develop feasible requirements.

Given the organizational analysis and the legacy software available within the domain, the do main requirements should be developed and provide requirements for the classification scheme, domain engineering method and support needs.

Given all the requirements, as described above, the impact to the organization needs to be determined.

The final activity assimilates the technical and business requirements, performs requirements feasibility and trade-off assessments, and ultimately harmonizes the reuse infrastructure requirements and balances competing needs.

4.3 Identify Software Process Requirements

Rationale

To determine the Software Process Requirements, it is necessary to evaluate the current software process for reuse potential and identify the software process factors. The software process factors are:
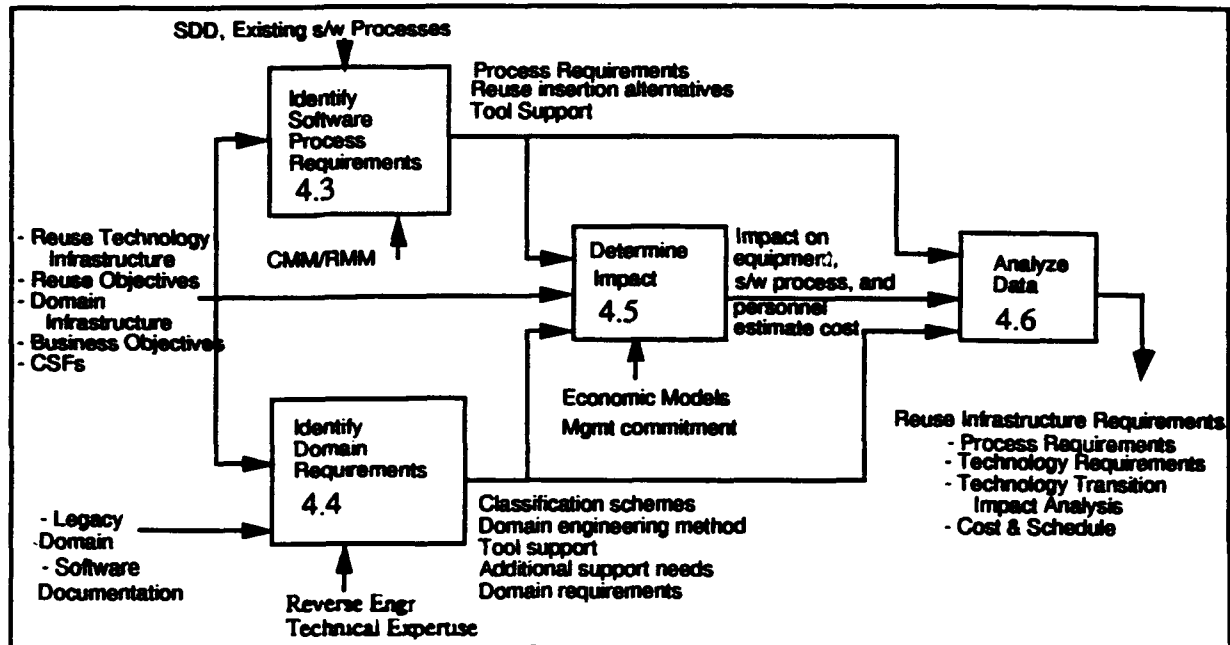
Figure 4-1 Requirements/Implementation Study

* The reuse-oriented characteristics of the software development process;

* Reuse usage patterns, such as when in the software development life cycle reuse is attempted;

* What information will be available to the engineer at the time of reuse; and

* How the users want the information presented must also be considered.

Inputs

Inputs to this task are:

* Long-Term Business Objectives;

* Reuse objectives and committed resources;

* Technology infrastructure; and

* Domain Infrastructure.

Processes

Techniques for analyzing software process factors include an analysis based on user surveys and surveys of technical project leaders, and evaluation of existing software development processes and software development standards for reuse insertion potential.

Software development plans for existing or anticipated reuse consumers as well as organization "software process" standards will be evaluated; these identify the form and content of reuse assets, as well as the timing in the life cycle when reuse will apply.

The objective is to fit reuse into the current software process with the least amount of difficulty.

Outputs

The software process requirements should include:

- Software reuse process requirements and reuse usage scenarios;

- Insertion of reuse-driven processes into the current software processes;

- Any recommended changes to the software development processes; and

- Current or potential automated support for a reuse inserted software process.

4.4 Identify Domain Requirements

Rationale

Domain requirements refers to those requirements introduced by the nature of the software being reused. For example, evaluating the prospects for architecture and feature recovery of the reusable software is needed when existing code, not designed for reuse, will constitute the bulk of the asset population.

In support of the DoD Software Reuse Initiative Vision and Strategy, we recommend pursuit of a reuse plan that includes domain analysis and modeling, generic architecture development, the creation/acquisition of domain-specific reusable assets and library support develop ment.

Inputs

Major inputs to this process include:

- Reuse objectives, already described;

- Domain infrastructure identified during the Organizational Analysis;

- Software documentation;

- Relevant CSFs; and

- Associated technical expertise related to the population of reusable assets and their underlying application domain(s).

Processes

During the Organizational Analysis the domain infrastructure was identified. The Requirements/Implementation Study will produce a report that enumerates the domain requirements for the organization. This information should be available for the asset creation, asset management and asset usage planning effort.

The implementation alternatives should be evaluated based on the current software processes, tools support and personnel. For example, if the organization uses a structured analysis approach to software development then the domain analysis methodology requirement could be "Domain Analysis shall be implemented using a structured analysis based approach".

Since domain analysis is relatively new, there are several domain analysis processes in existence with diverse goals, products, and processes. Determining the best approach to domain analysis requires considering the context in which the approach will be used.

Domain analysis approaches are considered in the context of five factors [WAR92]:

1. Current software process needs:

   a. Some domain analysis techniques are intended for a certain process model, e.g., waterfall.

   b. Where does domain analysis fall within the software process?

   c. Can the existing process be changed to incorporate domain analysis?

2. Existing knowledge/software base:

   a. Availability of domain experts.

   b. Availability of existing applications within a domain, e.g., access to the application and source of analysis and reusable assets.

   c. Possible evolution of the domain's technology.

3. Business objectives:

   a. How are the domain analysis products used?

   b. Organization must understand long and short term needs of domain analysis.

   c. When will the cost of the domain analysis be recovered?

d. What are the organizations's current and future needs?

e. Are there any plans for domain evolution?

f. Is there a plan prioritizing domain analysis and implementation efforts to meet the organization's needs?

4. State of domain knowledge:

a. Maturity of domain affects the cost of doing domain analysis. (i.e., a poorly understood domain could result in minimal benefits in comparison to the cost).

b. Chose a domain analysis method that can take advantage of the well understood areas of a domain.

5. Domain products:

a. What will be the domain analysis products? (i.e., domain model, generic architecture and domain-specific reusable assets)

b. Who will use the domain analysis products?

c. How will the products be used?

Outputs

The analysis should take into consideration all the above factors when deciding on the method, tool support and personnel requirements for defining the domain requirements, such as:

- Identified business and reuse objectives supported by domain requirements;

- Additional reuse objectives;

- Requirements for domain evolution;

- Recommended classification schemes, including (but not limited to) faceted, hierarchical, feature and semantic-model-based classification schemes;

- Recommended methodology for domain engineering;

- Recommended tool support and integration with current environment;

- Additional hardware and software needs; and

- Personnel requirements for domain engineering.

4.5 Determine Impact

Rationale

The level of investment should be determined up front and management should be prepared to commit the resources needed for implementation. The negative impact of insertion or adoption of new technology needs to be controlled and understood before implementation. To develop the requirements for change or redirection of the technology infrastructure, we must understand the impact of various alternative reuse methodologies, software process support, personnel requirements and implementation strategies (i.e., phased approach vs. all at once).

Inputs

The inputs into this activity are:

- Reuse/Technology infrastructure;

- Reuse objectives;

- Domain infrastructure;

- CSFs

- Process Requirements, tools support and alternatives;

- Domain Requirements, including classification schemes, domain engineering, and tool support; and

- Economic models.

Processes

The activities that will be used to evaluate the effect of reuse insertion into the way the organization develops software include:

- Define the potential impact of change on personnel;

    - Determine levels of bias toward reuse. *Institutionalized software reuse is relatively new and consequently misunderstood. As with any new technology, much is lost in the translation between technical capabilities and the potential of the technology in a user's specific application of that technology.*

    - Analyze current skill levels of personnel affected. *Institutionalized reuse will require training in new skills. The degree to which new training is required will depend on current skills, education, and experience.*

- Define skill level requirements for proposed change. *Based on the current skill levels of personnel relate the impact of any proposed hardware, software, and engineering expertise required.*

- Define equipment requirements;

  - Analyze the need to add additional personnel and the potential impact on current personnel, budgets, etc., in additional to adding or upgrading existing equipment.

- Define the software development process changes that will be necessary and impact on:

  - Personnel;

  - Equipment; and

  - Current tools.

- Define budgetary impacts of implementing the proposed solutions. *This process is repeated until there is a satisfactory and practical solution for the organization. Every attempt should be made to determine a target budget at the onset of the planning process.*

- Estimate the cost for a reuse infrastructure at an organizational level:

  - Include costs for all required consulting services, hardware, software, software support services, costs for incentives, royalties, license fees.

  - Consider the cost of different requirement implementation alternatives. *Estimates for different alternatives will be used to determine how well the organization's requirements will be met.*

  - Consider various costing scenarios such as, phased implementation, initial investment, etc.

  - Summarize all assumptions made. *Assumptions should be clearly identified to reduce or manage risk. As the assumptions are validated, a clearer overall picture will emerge and decision points can be approached with a higher level of confidence.*

- Estimate the gross return on investment:

- Estimate potential long-term savings from reuse. *Factors such as: stability of domain, existing and future technology, and market trends will be analyzed to produce best and worst case scenarios.*

- Estimate potential business opportunities. *Other factors such as: access to broader markets, current research and development being conducted by other organizations, availability of reusable assets (requirements, documentation, specifications). Also consider innovative approaches such as, teaming agreements, joint venturing, partnerships with universities, federally funded research and development corporations.*

- Determine feasibility of adding additional equipment and associated costs;

- Estimate current organizational personnel requirements:

  - Estimate personnel requirements by category (such as: software engineer, domain engineer, program manager, acquisition officer, etc.). *Consider all Personnel dedicated to the implementation and ongoing reuse process. Include management and system/software engineers.*

  - Estimate number of required support personnel by skill category. *Support personnel includes those assigned on a full time basis, such as library administrators, hotline or user support, and personnel such as consultants, facility maintenance, upper management or others as required.*

  - Estimate on-going training requirements. *Consider formal education, seminars, workshops, etc.*

- Ensure that the following issues are addressed within the Requirements/Implementation Study:

  - Major Risks.

  - Legal issues.

  - Scheduling requirements for implementation.

4.6 Analyze Data

The Requirements/Implementation Study activity considers all the information produced in the above activities and during the Organizational Analysis; and produces the Reuse Infrastructure Requirements. As shown in Figure 4-1, the "Analyze Data" activity assimilates the technical and business requirements, performs requirements feasibility and trade-off assessments, and harmonizes the reuse infrastructure requirements and balances competing needs.

The resulting analysis should produce the Reuse Infrastructure Requirements which should consolidate the:

- Goals and objectives;

- Business Requirements;

- Critical Success Factors;

- Software process requirements;

- Domain requirements;

- Impact Analysis;

- Estimated Cost and Schedule;

- Constraints imposed that may limit the alternatives during the development of the Reuse Implementation Plan, such as use of a specific CASE tool for software development;

- Recommendations; and

- Technical documentation to support concept exploration and design trade-off analysis.

See "Requirements/Implementation Study Sample Outline" on page A-2. for a recommended Reuse Infrastructure Requirements Report content.

5 Reuse Implementation Plan

5.1 Purpose

The purpose of the analysis activities previously described, was to identify the appropriate technology and business practices to meet organization needs. The purpose of developing a Reuse Implementation Plan is to provide the organization a tailored need-based plan that balances reuse needs with the current organizational environment.

The Reuse Implementation Plan will organize the overall reuse objectives and strategy, and requirements as they pertain to asset creation, asset management and asset usage into a cohesive plan.

The Reuse Implementation Plan should support senior management's efforts by:

- Ensuring that the organization is focusing on the reuse objectives;

- Cascading the reuse mission, vision and goals of the organization throughout the entire organization;

- Identifying the critical processes that need attention and improvement;

- Identifying the resources and the trade-offs that must be made to fund the reuse effort; and

- Reviewing progress and removing barriers that are identified.

5.2 Approach

The results of the Requirement/Implementation Study will be used by managers, senior systems analysts and software engineers to develop the Reuse Implementation Plan.
The reuse objectives formulated in the Organizational Analysis becomes the basis for the Reuse Implementation Plan. The Plan should support these goals and objectives.
The three primary tasks in Figure 5-1 illustrates the three primary areas that need to be addressed when developing a Reuse Implementation Plan:

- How and what assets will be created;

- How the assets will be managed; and

- How the assets will be used

based on the reuse objectives and infrastructure.
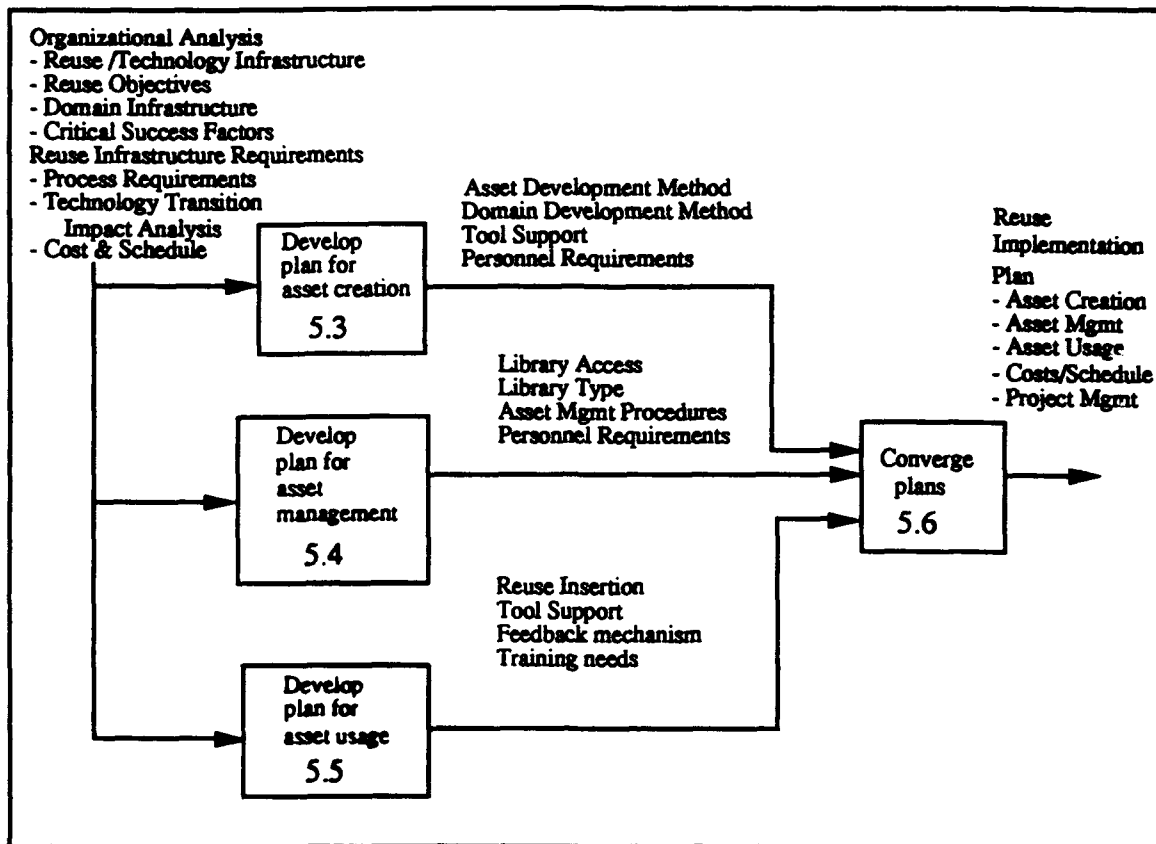
Figure 5-1 Reuse Planning

5.3 Develop Plan for Asset Creation

Rationale

The Requirements/Implementation Study, described in chapter 4, will be used to support the preparation of an asset creation plan. The decisions to be made include:

- How assets will be captured and organized;

- How knowledge about a domain will be represented; and

- How reusable assets will be produced.

Inputs

The inputs needed to plan for asset creation include:

- The business objectives;

- The reuse objectives, especially the domain-specific objectives;

- The current environment; and

- The reuse infrastructure requirements.

Processes

Based on the decisions made while analyzing the domain requirements [4.4], the organization should design an implementation plan for asset creation. The domain requirements described the organization's required needs to execute a successful domain-specific reuse program. The asset creation plan will identify the resources for implementing the domain requirements. The resources will include: human, automated tools support, implementation of a domain engineering method and an asset development method.

Outputs

The plan should enumerate:

- What assets will be developed such as, domain model, generic architecture, and implementation assets;

- What assets will be available from existing software base?;

- What changes to the software development process are necessary?;

- What methodology will be used to create assets?;

- What tools are necessary?;

- Impact on personnel, budget and the organization;

- How the products of domain analysis will be used. Will the products, models, and architectures be used to identify areas in the domain which need to be stabilized? Will the organization use the information to enhance Requests For Proposals (RFPs) and proposals?;

- What is the effect of new technology on the domain? Can the available technology enhance the performance of assets in the domain?;

- What domain analysis method will be used (i.e., Prieto-Diaz, Feature Oriented Domain Analysis)?;

- Who in the organization will be responsible for asset creation?;

- What training will be necessary to enact asset creation?;

- What is the implementation timeline for asset creation? and

- What are the specific objectives for asset creation? What business and/or reuse objectives do these objectives address?

5.4 Develop Plan for Asset Management

Rationale

Part of the Reuse Implementation Plan needs to include a strategy for asset management. Based on the requirements analysis, business objectives, reuse goals and CSFs identified previously, several decisions will be made.

The organization must decide on the type of library, if any, in-house vs. third-party library, technology support and management structure that will be used. The assets within a reuse library, their organization and the means to retrieve them can all support (or hinder) CSFs; conversely, CSFs may suggest technical implementation concepts such as asset quality attributes, asset generators, or automated asset composition.

Inputs

The information needed to develop an implementation plan for asset management include:

- Business requirements;

- Reuse infrastructure requirements;

- Business objectives;

- Reuse objectives including the domain-specific objectives;

- Impact analysis; and

- Current environment.

Processes

There are several issues that should be addressed:

- Does a library exist that meets the organization's needs?

- Would the organization get a return on investment by implementing an in- house library?

  - Hardware availability;

  - Software availability;

- Trained personnel;

- Training and education for library personnel;

- Training and education of users;

- Library model availability;

- Library population; and

- Library maintenance.

- Should the organization use a third-party library?

  - Communication link availability;

  - Means of transferring data between the user and the library as well as hours of operation become issues which may or may not be open for negotiation;

  - Hardware availability/compatibility;

  - Software availability/compatibility;

  - Training and education of users; and

  - Memorandum of Understanding (MOU) with third party library.

- How are assets qualified, certified and validated against domain requirements?

- How will asset management affect and be affected by asset creation and asset usage?

- What additional resources will be necessary for asset management? Are these resources easily available?

Outputs

This part of the Reuse Implementation Plan needs to:

- Define library needs;

- Define how assets will be acquired, stored, accessed, and maintained;

- Define the types of products suitable for reuse and develop criteria to validate these assets for new applications;

- Define standards for the various types of assets which will permit their certification for reuse;

- Define who is responsible for managing and maintaining the assets; and

- Define the tool support required, if any for asset management.

5.5 Develop Plan for Asset Usage

Rationale

The organization needs to formulate a plan to describe how and when in the software development life cycle reusable assets will be available. This plan needs to incorporate incentives for the potential users of the assets. It must provide for feedback to the other processes. Integration with current processes may be vital to realize the full potential of reuse.

Inputs

The inputs that support creation of a plan for asset usage are:

- Current software process information;

- Domain information;

- Anticipated changes to the software process;

- Asset Creation decisions; and

- Asset Management decisions.

Outputs

This part of the plan must provide for:

- Identification of the reuse processes and tools to be employed in using the assets, such as:

  - Software development processes with domain-specific reuse;

  - Automated tool support; and

  - Integration of library tools.

- The mechanisms and process for feedback to the management and asset creation process;

- Integration of assets into current software development tools, such as CASE tools;

- Incentives to the potential asset consumers to get their cooperation both in using the assets and providing assets and feedback;

- How assets can be identified by the user;

- Guidance and support for the end user that facilitates the reuse implementation plan.

5.6 Converge Plans

The areas described above, are strongly interwoven because decisions made in one area will influence decisions made in another area (i. e., assets created will strongly affect asset usage). Therefore, a spiral development method for creating the Reuse Implementation Plan is encouraged.

The Reuse Implementation Plan should converge all the requirements defined by the Requirements/Implementation Study and balance these requirements against the cost of different implementation scenarios to produce a plan that is both feasible and supports the reuse objectives of the organization.

The Reuse Implementation Plan should also consider that the introduction of reuse technology too quickly may not be effective, because:

- Ill-defined or non-existent software processes will inhibit the acceptance of new technology; by the time such "uptake" is feasible, alternative and more powerful technologies may be available on the market;

- The selection of technology may be faulty since a stable process was not available for defining the technology selection criteria; and

- Too rapid and haphazard introduction of technology may result in chaotic processes and introduce too many variables to permit reasonable reuse impact assessments; and

- Therefore, an organization should take an iterative approach to implementing reuse.

The Reuse Implementation Plan needs to enumerate:

- The reuse objectives;

- The domain of interest, current software development methodology, tool support, training needed, and estimate cost and development time;

- The software development process changes and a timeline for these changes;

- The technology support functions and tools necessary;

- An asset creation, management and usage strategy;

- An impact analysis;

- Cost and schedules;

- Personnel requirements;

- A project management plan; and

- A measurement plan for evaluating the reuse infrastructure and progress of the reuse program.

See "Reuse Implementation Plan Sample Outline" on page A-5. for suggested content areas for this plan.

6 Cost and Schedule

6.1 Purpose

The purpose of this section is to guide the organization toward estimating cost and schedule for a specific Reuse Implementation Plan. By collection and analysis of cost data, the organization can apply realistic estimates to various schedules for the establishment of a reuse infrastructure.

The costs which are identified up front during the Organizational Analysis can be monitored to evaluate the future impact or benefit of reuse.

6.2 Approach

The organization should perform a detailed analysis that measures the potential costs and benefits of reuse to an organization (across one or more departments or divisions). Information previously addressed in this document [chapters 3 and 4] as well as certain concepts detailed below will be used to perform this analysis. This approach will require an in-depth work study survey which computes the potential for savings for selected activities such as: software development processes, potential for reuse, domain factors, personnel factors, organizational mission, resources, facility and communication factors, and other factors which may be identified as critical to doing business (intangibles). This section will also provide some standard formulas used to calculate Cost Benefit Analysis and returns on investment.

Input

The information required for accurate analysis will be obtained from various areas of the organization. Based on the magnitude of change involved in institutionalizing reuse, different levels of financial detail will be required.

Processes

The process can be broken down into several steps:

1. Investigate reuse objectives and requirements

   This involves studying the current operations, problems, and reuse opportunities within the organization and its domain. Business objectives and constraints are identified and a conceptual model of the reuse infrastructure is developed to meet the objectives [Section 3.4].

2. Organization capabilities

   An organizational analysis is conducted using surveys, interviews, and question-naires. A sample work sheet is provided [See Appendix A.4] which, when completed, will indicate the organization's level of expertise in critical areas of the reuse infrastructure [Section 3.5].

3. Quantify organizational resources

   Identify human, corporate, and budget factors which will enhance or contribute to the various reuse implementation plans [Section 4.5].

4. Estimate the benefits (potential long term savings and potential business opportunities)

   Once the conceptual model of the reuse infrastructure is developed, the benefits resulting from achieving the business objectives are identified and estimated. These benefits are then scheduled over the projected life of the system.

5. Estimate the costs (infrastructure costs at organizational level)

   A plan for the proposed reuse infrastructure, showing the operational hardware and software configuration, is derived from the functional requirements. Major components of the system are identified. Hardware and software costs, and new operating and maintenance costs are estimated [Section 4.5]. These costs are then scheduled over the life of the system.

6. The cost and benefit analysis

   Applying cost-benefit techniques begins with reviewing the current environment (organization) and the reuse goals or anticipated future benefits. A financial analysis of the proposed system is performed using the estimated and quantified benefits and costs. Various financial indicators measuring the financial worth of the proposed infrastructure are calculated.

7. The interpretation of the analysis

   Once the financial indicators measuring the financial worth of the project are calculated, they are evaluated with respect to the business objectives and constraints of the organization. The results are evaluated and validated for consistency and soundness according to the standards and procedures of the organization's financial oversight authority.

8. Presentation of the analysis

   The final results of the analysis are summarized with all assumptions and estimations identified. This will allow for fine tuning and risk analysis/control.

6.3 Investment Summary

The fundamental concept behind the analysis of investment decisions is cost-benefit analysis. It is a procedure for organizing facts to determine the worth of a project. Simply, the costs associated with a project are compared to the net benefits expected from the project.

The cost-benefit analysis will produce an estimate of how soon the investment will pay for itself in reduced costs.
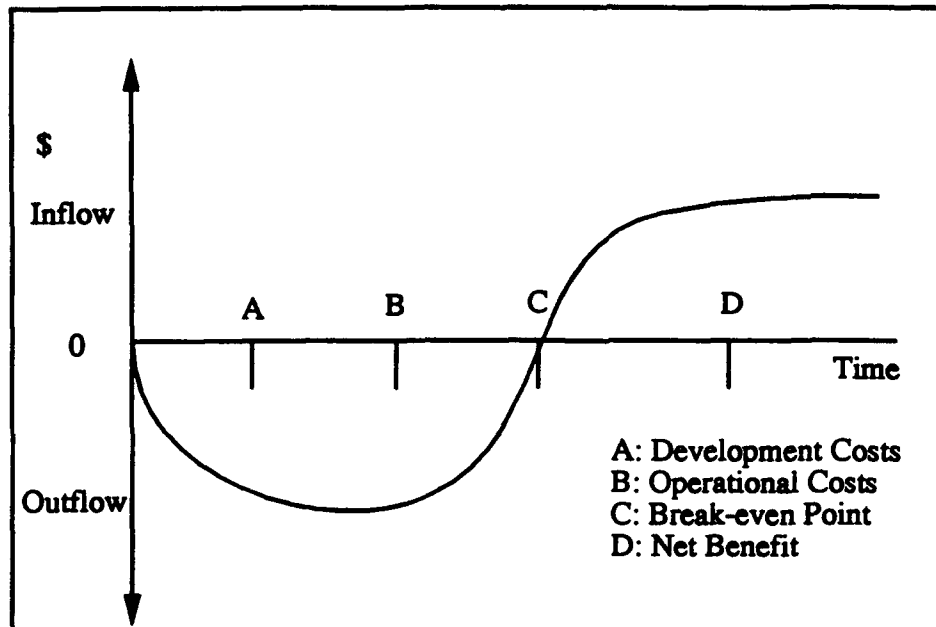
Figure 6-1 Investment Recovery

6.3.1 Payback

Payback determines how quickly a project recovers its initial investment or project costs. For reuse, the inflow of benefits occurs when the organization reuses existing components, whether they are architectures, models, designs, requirements, documentation, or actual software assets. The point when the inflow exceeds the project outlay is referred to as the break-even point [Figure 6-1]. The formula for calculating payback is:

$$\text{Payback} = \frac{\text{Project Cost}}{\text{Average Annual Benefit}}$$

Where:
Project Cost = Total start-up and ongoing cost of reuse
Average Annual Benefit = Actual cost savings over the life of the project

Example

Two approaches have been identified by the organization with the following cost and benefit data.

	1	2
Project Cost	$300,000	$100,000
Average Annual Benefit	$150,000	$60,000

Payback (1) $\frac{\$300,000}{\$150,000} = 2$ Years

Payback (2) $\frac{\$100,000}{\$60,000} = 1.67$ Years

6.3.2 Estimating the costs

Estimating the dollar value of the cost includes:

1. Reuse infrastructure hardware and software costs pertains to purchase, rental, lease of operational hardware and software required to implement the proposed system(s). This should include all new equipment and upgrades to existing systems. All rental and lease costs should be annualized.

2. Software development costs pertain to all costs associated with creating new reusable software (domain models, architectures and reusable components), and modifying or classifying existing software.

3. New operating costs, represented by any new operating costs or increased operating costs resulting from this implementation. For instance, personnel training, storage, facility etc.

4. Maintenance costs for components, hardware, and system administration.

Output

By collecting the financial data and applying the formulas, the organization will be able to more accurately estimate the costs and benefits of proposed solutions, as well as the return on investment. The accurate identification, collection, and analysis of data will result in:

1. Estimate for one-time design and implementation costs of reuse.

2. Estimates of the ongoing costs of implementing reuse.

3. A summary analysis of the economics of the proposed reuse infrastructure.

4. Identification and documentation of intangible considerations which may affect management's decision.

APPENDIX A - Workproducts

A.1 Organizational Analysis Sample Outline

1. Develop executive summary portion of the feasibility report.

   a. Identify all of the major findings resulting from the survey.

   b. Identify the recommended solution alternatives (if there are multiple) and any long or short term solutions.

   c. Identify the major goals and objectives that the proposed solutions will address.

   d. Identify the cost and benefits of the proposed solution(s).

2. Develop a summarized version of the method that was used

   Identify the people that were interviewed and the types of materials that were utilized, (surveys, questionnaires etc.)

3. Define the organization's business long range goals [3.4.1]

   a. Organizational Chart

   b. Correlate goals to organizational level

   c. Identify any problems and solutions

4. Determine Domain-Specific infrastructure [3.4.2]

   a. Analysis of domain

   b. Context diagram if applicable

   c. Future trends

   d. Domain-Specific goals

5. Define the current software development environment [3.4.3]

   a. Operational hardware and software

   b. Quantity of software produced

   c. Quantity and quality of assets currently available

    d. Controls that are in place, for metrics collection and analysis

6. Critical success factors [3-4 on page 12]

    a. List critical assumptions, critical decisions and critical information

    b. List individual CSFs

7. Define the recommendation being proposed

    a. Include objectives and goals which will be met by implementing reuse

    b. Identify potential constraints in the form of impact on the organization

    c. Identify the benefits of following the recommendation

    d. Identify the scope of the proposed recommendation

8. Complete the report and include appendices that provide supporting documentation for the body of the report

    a. Include interview data

    b. Include sample questionnaires

    c. Include appropriate documentation that was collected or developed during the interview process

A.2 Requirements/Implementation Study Sample Outline

1. Executive summary portion of the requirements analysis report

    a. Identify all of the major findings resulting from the analysis

    b. Identify the recommended solution alternatives (if there are multiple) and any long or short term solutions

    c. Identify the major goals and objectives that the proposed solution will address

    d. Identify the cost and benefits of the proposed solution(s)

2. Summarized version of the study method that was used to gather the information

Identify the people that were interviewed and the types of materials that were utilized, (surveys, questionnaires, etc.)

3. Define the organization's business requirements [3.4]

   a. Goals and Objectives

      Organizational Chart

      Correlate goals to organizational level

      Identify any problems and solutions

   b. Critical Success Factors

      List critical assumptions, critical decisions and critical information

      List individual CSFs

   c. Current Technology Structure

      Operational hardware and software

      Quantity of software produced

      Quantity and quality of assets currently available

      Controls that are in place, for metrics collection and analysis.

   d. Summation of business requirements

4. Software process requirements [4.3]

   a. Current Software Processes

   b. Recommended reuse software processes to be incorporated into current software development processes

   c. Reuse usage scenarios

   d. Recommended changes/additions to software development processes

   e. Current automated support for software processes

5. Domain Requirements [4.4]

   a. Assessment of domain

   b. Context diagram if applicable

c. Future trends

d. Domain-specific goals and requirements

e. Domain readiness assessment (domain model, generic architecture, assets and domain expertise)

6. Technology Insertion Impact Assessment [4.5 and 6]

a. Summarize the potential impact to personnel and equipment

   Current Personnel/Required Personnel

   Training necessary

   Current Equipment/Required Equipment

b. Estimate

   User requirements

   Cost of reuse infrastructure

   Return on Investment

   Present alternative costing scenarios

c. Financial Feasibility

   Equipment cost

   Training cost

   Personnel cost

7. Define the recommendations being proposed.

a. Identify objectives and goals which will be met by implementing reuse

b. Identify potential constraints in the form of impact on the organization

c. Identify the benefits of following the recommendations

d. Identify the scope of the proposed recommendations

8. Ensure that the following issues are addressed:

a. Major Risks

b. Outside consulting or support services required

  c. Scheduling requirements for implementation

 9. Complete the report an.' include appendices that provide supporting documentation for the body of the report

  a. Include interview data

  b. Include sample questionnaires

  c. Include appropriate documentation that was collected or developed during the interview process

A.3 Reuse Implementation Plan Sample Outline

Reuse implementation should occur in a detailed, tailored, phased approach. Just as no two organizations are exactly alike, no two implementation plans are exactly alike.

 1. Executive summary portion of the Reuse Implementation Plan.

  a. Identify all of the major decisions made as a result of the plan.

  b. Identify the recommended solution alternatives (if there are multiple) and any long or short term solutions

  c. Identify the major goals and objectives that the proposed solution will address

  d. Identify the cost and benefits of the proposed solution(s)

 2. Summarize the method that was used to gather the information

  Identify the people that were interviewed and the types of materials that were utilized, (surveys, questionnaires, documentation, etc.)

 3. Define the Organization's [3.4.1]

  a. Reuse mission

  b. Reuse vision

  c. Reuse goals and objectives within the organizational chart

 4. Identify the critical processes that will be improved/implemented

  a. In the software development practices

b. In the management practices

5. Summarize the potential impact to personnel and equipment [4.5]

a. Current personnel/required personnel

b. Training necessary

c. Current equipment/required equipment

6. Phased plan for reuse process insertion

a. Project management

b. Reuse insertion into current processes [4.3]

c. Asset creation [5.3]

   process decisions

   equipment, tools, training, personnel decisions

d. Asset management [5.4]

   Decision on library type, resources, in-house or third party)

   Implications to organization

   Personnel Training

e. Asset usage [5.5]

   Type of assets that will be available

   Personnel training

f. Automated tools support for reuse infrastructure

g. Measurement plan

7. Financial Cost [4.5 and 6]

a. Equipment cost

b. Training cost

c. Personnel cost

8. Ensure that the following issues are addressed within the Reuse Implementation Plan:

    a. Major Risks

    b. Outside consulting or support services required

    c. Scheduling requirements for implementation.

9. Complete the report and include appendices that provide supporting documentation for the body of the plan

    a. Include interview data

    b. Include sample questionnaires

    c. Include appropriate documentation that was collected or developed during the planning process

APPENDIX B - Related Documents.

This appendix will

- Describe the CARDS documents;

- Describe when the CARDs documents are most useful for reuse project planning; and

- Provide a table relating the CARDS documents and other documents to the reuse project planning phases.

B.1 CARDS Documents

B.1.1 Acquisition Handbook

The *Acquisition Handbook* is aimed towards all Government Program Managers and their support personnel, such as Contracting Officers and Administrators, procurement attorneys, and program control, involved in systems, subsystems and component acquisition. The concepts discussed assume that the reader has at least three years in acquisition.

The Handbook assists them in incorporating software reuse into all phases of the acquisition life cycle, from concept exploration to Post Deployment Software Support (PDSS). It is not a "cookbook" for every possible reuse issue or strategy, rather it is meant to help develop and tailor reuse programs.

The goal of the Acquisition Handbook is to encourage software reuse during the acquisition and maintenance portions of the life cycle process, ranging from planning the acquisition strategy through awarding the contract to managing the effort and follow-on support. Software reuse guidance is presented by providing methods, examples, recommendations and techniques to implement various reuse strategies throughout the acquisition life cycle.

This Handbook can be used during the development and execution of the Reuse Implementation Plan.

B.1.2 Component Provider's and Tool Developer's Handbook

The *Component Provider's and Tool Developer's Handbook* was developed under the Central Archive for Reusable Defense Software (CARDS) Program to help facilitate software reuse adoption. Government developers and software industry vendors supporting government acquisitions are provided with guidance for developing/creating domain-specific reusable components and tools supporting reuse. The goal of this handbook is to stimulate the development and commercialization of large scale components and tools for vertical domains. Focus is placed on architecture-centric, library-assisted software reuse. It is assumed that the reader is familiar with the design and development of software. The audience for this handbook consists of:

- government: domain and System Program Office (SPO) engineers,

- contractors: component creators and tool developers.

B.1.3 Direction Level Handbook

The *Direction Level Handbook* is directed towards acquisition executives of all the services to facilitate the institutionalization of software reuse. The audience of Program Executive Officers (PEOs), Designated Acquisition Commanders (DACs), and their supporting staff, are provided with a framework to assist them in establishing plans to manage reuse across their systems and to reach the goals outlined in the DOD Software Reuse Vision and Strategy document. Considerations are provided to assist in incorporating software reuse into the initial planning stages of an acquisition, as well as at critical points within the acquisition life cycle. The options provided the executive allows him to gain the greatest benefits from software reuse while optimizing the use of shrinking resources.

This Handbook can be used to determine the reuse objectives, business requirements, domain requirements, reuse/technology infrastructure requirements and the critical success factors during the Organizational Assessment and Requirements/Implementation Study activities.

B.1.4 Engineer's Handbook

The *Engineer's Handbook* was developed under the Central Archive for Reusable Defense Software (CARDS) Program to help facilitate advances in software reuse techniques and technologies. This document provides guidance to Government System Program Office (SPO) Engineers on envisioned changes to their duties and responsibilities as domain-specific software reuse becomes incorporated into mainstream DoD system/software acquisition and engineering processes.

The intended audience of this Handbook is SPO Engineers who are responsible for pre-Request for Proposal (RFP) engineering activities, proposal evaluation, monitoring of engineering activities after a contract is awarded, and monitoring of ongoing sustaining engineering efforts (or maintenance) of fielded products.

To fully utilize the concepts in this Handbook, it is recommended that the reader be familiar with software development techniques and methodologies, existing Government regulations (such as DOD-STD-2167A,MIL-STD-499, MIL-STD-1521B, and emerging DOD-STD- 498/SDD), and the acquisition process.

B.1.5 Library Development Handbook

The process of developing a domain-oriented reuse library is elaborate. This Library Development Handbook provides an overview of the phases involved in developing such a

library: domain analysis, library encoding, and library population. This Handbook presents a generic library population process that has been developed by the Central Archive for Reusable Defense Software library development team. This Handbook enumerates specific instructions and examples for populating a domain-oriented reuse library, based on this library population process. We are currently assessing the implications of legal issues on our policies and procedures. Appropriate risk reduction procedures will be detailed in subsequent releases.

B.1.6 Library Operation Policies and Procedures

The *Library Operation Policies and Procedures (LOPP)* manual consists of two volumes. Combined, these volumes serve as a comprehensive guide for implementing and maintaining a reuse library. Volume One outlines recommended Policies and Procedures for Library operations. Volume Two provides detailed Operational Instructions, or "day-to-day" processes. Volumes One and Two are partitioned to allow for maximum modularity and ease of use for the document user.

B.1.6.1 Volume One, Policies and Procedures

Volume One, Policies and Procedures, is aimed toward upper-level management through the technical supervisor level and provides a high level view of the policies and procedures for operations. Volume One provides access to information concerning strategies for managing and maintaining an existing reuse library system, including recommendations on how to implement operations of the library, tables showing suggestions on how to assure task accountability and completion, and an expected level of knowledge for the staff at hand.

This volume of the LOPP can be used to develop and execute the requirements for the asset management portion of the Reuse Implementation Plan.

B.1.6.2 Volume Two, Operational Instructions

Volume Two, the Operational Instructions, targets the technical individual who will be implementing the policies and procedures of Volume One. The Operational Instructions provide detailed descriptions of the day-to-day happenings for implementing, and maintaining a reuse library. This volume provides quick access to the specific area of interest and allows the reader to retrieve only that information specific to their area of interest or concern. In addition to outlining the CARDS daily operations, Volume Two contains the forms referenced in this document.

This volume of the LOPP can be used to develop and execute the asset management portion of the Reuse Implementation Plan.

B.1.7 Market Study

The Market Study will supply the Central Archive for Reusable Defense Software (CARDS) program with information regarding the current state-of-the-practice of software development

and maintenance within the military services. Results of analysis of collected data will reflect current practices, as well as identified needs within each military service for establishment of a suitable infrastructure to enable reuse. Full comprehension of the software needs of potential reusers is required before CARDS can address its ultimate goal of facilitating widespread software reuse throughout the DoD. The focus of results will therefore be geared toward facilitating the CARDS process of institutionalizing software reuse within the Department of Defense (DoD) by more finely concentrating our development, technology transfer and franchising efforts toward satisfaction of identified requirements.

B.1.8 Technical Concept Document

The Central Archive for Reusable Defense Software (CARDS) program is a concerted DoD initiative to transition advances in the techniques and technology of library-aided, architecture-centric, domain-specific software reuse into mainstream DoD software procurement. This technology transition effort involves the development of a domain-specific reuse library for researching technologies and methodologies for creating reuse libraries. This document describes the technical concepts employed towards the development of the CARDS Command Center Library.

CARDS views a reuse library as reusable software components, a library model and supporting library applications. This view, and it's consequences on library development are presented in this document. A discussion of model-based reuse library infrastructure presents a model-based view of library development, with an emphasis on distinctions between domain and library modeling.

The component qualification process is presented as an integral part of the library development process. Modeling of the command center library has evolved to support development and integration of various reuse library applications. The CARDS system composition and component qualification tools are discussed.

This document also presents technical aspects of the operational library, such as distribution options (e.g., AFS), reuse library security issues (an overview of the CARDS security analysis is presented), and advances made in interoperation between reuse libraries.

B.1.9 Training Plan

The Central Archive for Reusable Defense Software (CARDS) Training Plan serves as a comprehensive guide for creating training courses and training materials on domain-specific reuse for Department of Defense (DoD) organizations, DoD contractors, system engineers, and university professors. The Training Plan provides guidance for conducting three specific software reuse training courses for four different audiences. The intent of the courses in the Training Plan is to demonstrate how software reuse can reduce development and maintenance time and costs, reduce project risks, and increase productivity.

B.1.10 Application Engineering With Domain-Specific Reuse Course

This course description was developed under the Central Archive for Reusable Defense Soft ware (CARDS) Program to help facilitate advances in software reuse methods. This course description provides guidance on developing a course to teach system and software engineers how to incorporate domain engineering products into the software development process.

The course outlines begins by introducing students to reuse and domain-specific reuse. Domain engineering is defined and the products of domain analysis are explored. Reuse libraries are discussed, and the students are instructed in how to incorporate domain engineering products, located in a reuse library, into the application engineering process. The course was developed for presentation to both Government and industrial personnel. It can be tailored for presentation at the university level.

B.2 Document Matrix

This table correlates the CARDS documents, described above, and other related reuse oriented documents to the reuse project planning phases.

Table B-1   Documents Related to Project Planning Phases

Document	Organizational Analysis	Requirement/ Imple- mentation Study	Reuse Implementation Plan	Execute Reuse Plan
Air Force Software Reuse Implementation Plan [AIR92]			xxx	xxx
The Army Strategic Software Reuse Plan [ARMY92]	xxx	xxx	xxx	xxx
ASSET Set Up Plans [ASSET91]		xxx	xxx	
ASSET Operations Plan [ASSET92]			xxx	xxx
CARDS Acquisition Handbook [CARDS94a]			xxx	xxx
CARDS Direction Level Handbook [CARDS94b]	xxx	xxx		
CARDS Engineer's Handbook [CARDS94c]				

Document	Organizational Analysis	Requirement/ Implementation Study	Reuse Implementation Plan	Execute Reuse Plan
CARDS Library Development Handbook [CARDS93a]		xxx	xxx	
CARDS Market Study [CARDS94d]	xxx			
CARDS Training Plan [CARDS94e]			xxx	xxx
CARDS Library Operations Policies and Procedures [CARDS94f]			xxx	xxx
CARDS Technical Concepts Document [CARDS94g]		xxx	xxx	
CARDS Engineer's Handbook [CARDS94h]			xxx	xxx
CARDS Component and Tool Developers Hand book [CARDS94i]			xxx	xxx
CARDS Application Engineering With Domain-Specific Reuse Course Description [CARDS93c]			xxx	xxx
Application of Feature Oriented Domain Analysis to the Army Movement Control Domain [COHEN91]		xxx	xxx	xxx
Criteria for Comparing Reuse-Oriented Domain Analysis Approaches [DIAZ91]		xxx	xxx	
Domain Analysis Guidelines [DISA92b]		xxx	xxx	xxx

Document	Organizational Analysis	Requirement/ Implementation Study	Reuse Implementation Plan	Execute Reuse Plan
DoD Software Reuse Initiative Vision and Strategy [DOD92]	xxx	xxx	xxx	
NASA Manager's Handbook for Software Development [NASA90]	xxx	xxx	xxx	xxx
NASA Recommended Approach to Software Development [NASA92]	xxx	xxx	xxx	xxx
NATO Standard for the Development of Reusable Software Components [NATOa]			xxx	xxx
NATO Standard for Management of a Reusable Software Component Library [NATOb]			xxx	xxx
NATO Standard for Software Reuse Procedures [NATOc]			xxx	xxx
Navy Reuse Implementation Plan [NAVY93]	xxx	xxx	xxx	xxx
Software Architecture [PERRY91]		xxx	xxx	xxx
Draft Concept of Operations Document for the National Test Bed Software Reuse Program [SDIO91]		xxx	xxx	
SPA & SCE - Sorting it Out [SEI92]	xxx	xxx		
SPC Reuse Adoption Guidebook [SPC92a]	xxx	xxx	xxx	
SPC The Reuse Capability Model [SPC92b]	xxx	xxx	xxx	

Document	Organizational Analysis	Requirement/ Implementation Study	Reuse Implementation Plan	Execute Reuse Plan
Introducing Systematic Reuse to the Command and Control Systems Division of Rockwell International [SPC92c]			xxx	xxx
STARS Reuse Library Process Model [STARS91]		xxx	xxx	xxx
STARS Reuse Concepts Volume1 - Conceptual Framework for Reuse Processes (CFRP) Version 2 [STARS92a]	xxx	xxx	xxx	
STARS Reusable Asset Management Process Model [STARS92b]		xxx	xxx	
STARS Reuse Maturity Model: Guidelines for Reuse Strategy Formulation [STARS92c]		xxx	xxx	

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APPENDIX D - Glossary

acquisition	The phase of library population in which potential software products are identified, screened and then evaluated for inclusion in the library.
application domain	The knowledge and concepts which pertain to a particular computer application.
architecture model	A model that represents the interrelationships between system elements and sets a foundation for later requirements analysis and design steps.
architecture modeling	The process of creating the software architecture(s) that implements a solution to the problems in the domain.
assessment	The act of evaluating.
asset	A set of reusable resources that are related by virtue of being the inputs to various stages of the software life cycle, including requirements, design, code, test cases, documentation, etc. Components are the fundamental elements in a reusable software library.
classification scheme	The organization of reusable software components according to specific criteria.
context	The circumstances, situation, or environment in which a particular system exists.
critical assumptions	A group of assumptions about a business segment, competitor, or industry that supports or validates an organization's critical success factors.
critical decisions	The decisions that must be made by an organization to have an impact on its critical success factors.
critical information	The information that is required by an organization's operational system to enable them to support the organization's critical success factors.
critical success factor (CSF)	An internal or external business-related result that is measurable and that will have a major influence on whether a business segment meets its goals.
domain	An area of activity or knowledge containing applications which share a set of common capabilities and data.

domain analysis

The process of identifying, collecting, organizing, analyzing, and representing the relevant information in a domain based on the study of existing systems and their development histories, knowledge captured from domain experts, underlying theory, and emerging technology within the domain.

domain analyst

An individual skilled in domain analysis methodologies. The Domain Analyst is responsible for defining the language, tools, and techniques used in performing the domain analysis. This person also documents the domain model and may be responsible for defining any generic architectures associated with the domain.

domain architecture

High-level paradigms and constraints characterizing the commonality and variances of the interactions and relationships between applications within a domain.

domain constraints

Represent the mission-level requirements identified within the boundaries of the domain. They determine the functionality of the system expressed in terms and language dominant within the domain.

domain engineering

An encompassing process which includes domain analysis and the subsequent construction of components, methods, tools, and supporting documentation that address the problems of system/subsystem development through the application of the knowledge in the domain model and software architecture.

domain expert

An individual with extensive knowledge of a particular domain.

domain model

A definition of the functions, objects, data, and relationships in a domain, consisting of a concise representation of the commonalities and differences of the problems of the domain and their solutions.

domain modeling

The process of encoding knowledge about a domain into a formalism.

domain-specific library

A library whose components are bound by a specific domain.

domain-specific reuse

Reuse that is targeted for a specific domain (as opposed to reuse of general purpose workproducts). It typically

	involves reuse of larger workproducts (subsystems, architectures, etc.) that general purpose reuse.
feature	A prominent or distinctive user-detectable aspect, quality, or characteristic of a software system or systems.
franchise	An organization (government/contractor/commercial) that is committed to developing a domain-specific reuse capability that: 1. forms reciprocal obligations and a cooperative partnership with CARDS 2. has a business agreement with CARDS that enumerates the range and level of services to be provided by CARDS and obtained from the franchisee. 3. shares a model-based, library-assisted technical vision with CARDS
generic architecture	A collection of high-level paradigms and constraints that characterize the commonality and variances of the interactions and relationships between the various components in a system.
goal	1. A statement of an organization's medium-to-long-term target or direction of development. A goal is achieved when all objectives relating to it have been achieved. Typically, goals do not have exact timetables or achievement measures associated with them. 2. Specific targets that a business segment intends to meet within a specified time frame to further the achievement of more general objectives.
infrastructure	1. The basic underlying framework or features. 2. The basic installations and facilities on which continuance and growth of an organization depend.
knowledge blueprint	A flexible plan to transition knowledge to the community.
library	A collection of components that are cataloged according to a common classification scheme and a set of applications that provide a mechanism to browse and retrieve components.
library model	A model that represents the domain components and the relationships between them.
library population	The process of acquiring/developing components in support of the library model.

memorandum of understanding	An agreement stating terms of cooperation between two entities.
mission	A general statement of the purpose and nature of the enterprise.
mission statement	A broad description of an enterprise's purpose, policies, and long-range strategy and vision.
model	A representation of a real-world process, device, or concept.
modeling	The process of creating a model.
objective	An end or target state that is achieved by accomplishing all critical success factors related to it. Objectives are short-term (12 to 24 months or less), with defined achievement measures.
reusable component	A component (including requirements, designs, code, test data, specifications, documentation, expertise, etc.) designed and implemented for the specific purpose of being reused.
reuse	The application of existing solutions to the problems of system development. Reuse involves transfer of expertise encoded in software-related work products. The simplest form of reuse from software work products is the use of subroutine/subprogram libraries for string manipulations or mathematical calculations.
reuse library	A library specifically designed, built, and maintained to house reusable components.
reuser	One who implements a system through the reuse process.
software architecture	High-level paradigms and constraints characterizing the structure of operations and objects, their interfaces, and control to support the implementation of applications in a domain. Includes the description of each software component's functionality, name, parameters and their types and a description of the component's interrelationships.